***PPT Slide 1**: Intro slide- 'Is Briquetting The Answer?' with pic. Of hand-held briquette.*

Good Morning. I come to you from Nairobi Kenya where I have developed and commercialized a very low-tech process for the production and briquetting of charcoal. It started with a philosophically driven ideal, went through much trial and error, but eventually came to an interesting commercial success that can be easily replicated in other countries.

I live in a part of the world where an awesomely rapid rate of deforestation is being experienced as populations expand and heavier demands are being made of shrinking natural resources. Huge numbers of trees are clear felled to produce charcoal, the urban consumer's preferred cooking fuel. The environmental deterioration in many parts of East Africa really is noticeable from one day to the next.

***PPT Slide 2:** Mt. Kenya forest devastation with bare charcoal kiln patches.*

Kenya consumes a minimum of 440,000 tons of charcoal domestically per year. At the poor earthen-kiln conversion rate of 10%, this represents 4.4 million tons of live wood. In addition to this, exports of indigenous hardwood charcoal to the Middle East have begun recently, for which we have no figures.

But, Kenya, like many developing countries is full of contradictions- little is wasted- even beer tins are collected from ditches and casually recycled. While entire forests are cleared for charcoal production, large agro-industries such as timber and sugar processors discard huge amounts of waste biomass on a daily basis- often spending money on its disposal.

PPT Slide 3: *Sawdust & Bagasse. Both pics titled with tons of the respective material discarded in Kenya*

I have developed an appropriate solution to provide affordable cooking fuel and reduce deforestation. The equipment is low-tech, low-cost, labour intensive and uses only local resources. There is virtually no limit to either raw materials or market size for the finished product. The process is highly profitable and easily replicated.

My initial goal was to produce charcoal briquettes from sawdust. I had limited money, and started off experimenting in my spare time and gaining knowledge as I went. The Internet was a hugely valuable resource, and CREST's 'Stoves' list members were informative and supportive.

It was quickly apparent that there were two issues to address: carbonization and densification, or briquetting. I have resolved both independently and have progressed from briquetting two tons of charcoal powder per week to five tons per day. We are still expanding the Nairobi facility and will soon set up production centers in other Kenyan towns.

As for carbonization, I have developed a method that can efficiently and cleanly convert air-dried particulate biomass in commercial quantities. We have recently struck a deal with Kenya's largest sugar factory to produce 10 tons of charcoal briquettes per day from surplus bagasse.

In my opinion, what can be done in Kenya can be done in any developing country.

Large concentrated reserves of convertible biomass aren't always associated with big industry though. In the middle of the Nairobi urban environment I stumbled across a literal coal mine- thousands of tons of charcoal dust laid down by generations of charcoal vendors.

PPT Slide 4: *loading dust onto lorry at charcoal vendor's site. Bullets below-*
3,000,000*. People.*
40% *using charcoal (600 tons/day)*
15% *dust discarded (90 tons/day)*
60% *dust is collectable at vendor's sites:* **54 tons/day**

Dust accumulates at the rate of 10 to 20% of the weight of all charcoal brought into Nairobi. Of the three million people in Nairobi, we estimate 40% of the domestic and small-scale commercial cooking fuel requirement is met by charcoal. This amounts to charcoal consumption in the region of 600 tons per day. 15% of this ends up as discarded dust- 90 tons of it daily. The collectable reserves in Nairobi alone may be over 2,500 tons. This charcoal dust does not degrade over time, as evidenced by coins dating back to the 1920's that are regularly sieved out during processing.

I started off as my own customer- using 40 bags a week for heating chick brooders in my poultry farm. I now produce 30 tons of charcoal vendor's waste briquettes per week, employ 16 people, and am expanding to meet a growing demand. I've dedicated a new company called 'Chardust Ltd. to this endeavor, and we aim to break the 10-ton/day barrier within the next six months. We also plan to open up more plants in the Kenyan cities of Mombasa, Nakuru and Kisumu. This is purely profit-driven expansion.

PPT Slide 5*: photo mosaic of 1.sieving, 2.milling, 3.adding water and 4.extrusion.*

The salvage process is simple- sieve, mill the big bits and add them back, mix in water and extrude using locally-made machines that are essentially scaled-up meat grinders.

The extruded product is sun dried, which takes a day and a half when sunny, or up to three days during rainy periods. We pack in several sizes- the 50 kg bags sell for the equivalent of $3.15- that's 63 dollars per ton.

***PPT Slide 6**: Drying racks… lots of VWB being packed.*
Bullets indicating comparative costs – VWB V.S. Lump Charcoal

By the kilo, vendor's waste briquettes are 40% cheaper than lump wood charcoal. By the kilocalorie we are 20% cheaper, the discount being diluted by the high ash content from impurities in the powder. This ash is a mixed blessing though- it acts as the binder, and being a 'bulk' component; it is a fire retardant- extending the burn time of the briquette; an advantage to most cooking and heating applications.

Vendor's waste briquettes are easily marketed. They do not smoke, spark or produce a noticeable smell when burning. There is no added smoky organic binder. Charcoal waste fines themselves are derived from brittle completely carbonized chunks of charcoal, so there are no smoky semi-carbonized brands as are found in lump-wood charcoal. Feedback from local domestic consumers indicates that the small amount of waste fines, long cooking time and low price are the three most appreciated aspects of Vendor's Waste Charcoal.

***PPT slide 7**: pie chart- Costs & Profit of Nairobi VWB production at 4 ton/day*

As 'eco-tourism' grows and 'green' ethics are applied, so does the demand for environmentally friendly alternative fuels. Last month alone, one of our customers operating three tourist safari camps in the Maasai Mara Game Reserve bought 20 tons of vendor's waste charcoal briquettes for cooking and water heating. This replaced a daily consumption of around 2 tons of locally collected firewood. That we can provide an aesthetically acceptable substitute to firewood and lump wood charcoal without the typical 'value added' additional cost, allows the demand for this product to grow in the complete absence of advertising. Our briquettes are becoming increasingly popular in the home, in the full spectrum of restaurants, in poultry farms for heating chick brooders, in game lodges and camps, in several schools, hospitals and a prison.

Outside the Nairobi urban environment there are opportunities to make charcoal briquettes of a different kind. 123,000 tons of

sawdust is discarded annually in Kenya. At least this much bagasse- fibrous sugar cane waste- is dumped and burned as well. With particulate biomass like this, the problem in briquetting has been how to carbonize efficiently. The most common method is to briquette first and carbonize second- a costly and often inefficient process. The least cost approach to briquetting charcoal has been proven- carbonize first, briquette second. If you can carbonize particles, then low-pressure extrusion of the carbonized material can produce a charcoal briquette with a proven price advantage and a ready market.

There are many densification methods. For higher output and efficiency, for example, roll briquetters can be introduced. The common requirements are cost effectiveness and simplicity. The primary goal is to produce a product that competes in the marketplace with lump wood charcoal.

Over the past four years we have developed a commercially viable, clean and efficient method of carbonizing particles of biomass. This achievement has led to a pilot project in co-operation with Kenya's largest sugar factory. The product here is a charcoal briquette made from bagasse- we call it 'CaneCoal'. Conversion efficiency from air-dried bagasse to charcoal is typically 25%. CaneCoal binders are clay and the sugar factory centrifugal waste product called 'mud'. Edible binders such as molasses and starch are avoided. Both the bagasse and the mud have a negative value for the sugar company- this provides a very positive boost to CaneCoal profitability.

PPT slide 8: *picture of the carbonizer in action.*

This carbonizer is made of brick, cement, old 45-gallon drums and ceramic tiles. It flares the white smoke produced by carbonizing biomass and has a conversion rate of 36% for air-dried sawdust and 25% for bagasse. The prototype unit pictured can process over 400 kg of air-dried sawdust per hour and is easily scaled up for much higher throughputs.

Some of the heat produced during carbonization can be used to pre-dry raw material or perform other simple tasks such as baking

bricks or drying foodstuffs. We have yet to run carbonization trials on rice husk, cotton stalks, coffee husks or similar products, but there should be no major problems in shifting from one particulate raw material to another. This method of carbonization was developed for charcoaling sawdust, which is the 'worst case' raw material- certainly when compared with the more fibrous bagasse.

Our agreement with the Mumias Sugar Company came out of the blue. Initial trials with the carbonizer on air-dried bagasse had proven that a good quality charcoal briquette could be produced. What we hadn't anticipated was such an enthusiastic reception to our proposal. We will construct a carbonization and extrusion briquetting facility to produce CaneCoal at the factory at the company's expense.

PPT slide 9: *Mumias financial highlights- establishment cost & returns.*

After deducting savings on the cost of surplus bagasse disposal and adding back revenues on CaneCoal sales during the six month startup period, the proposed plant, producing 10 tons of charcoal briquettes per day, will have cost Mumias $60,000. We-Chardust Ltd.- will assist in the initial marketing as part of the agreement and then receive a small production based royalty. Annual CaneCoal sales should stabilize in the region of$180,000, with an investment payback period of less than one year.

Basics work. Imported technology has a miserable history of failure in East Africa. Complex labour-saving devices are generally doomed to early extinction. High-grade steel melts. Foolproof equipment is outsmarted. Multiple redundancies suffer the domino effect. There is no substitute for unskilled labour in a country with 70% unemployment. If process equipment can be made from locally available or salvaged materials, it should be done. This flies in the face of big business though, and goes completely against the grain of most foreign aid programs that require host-supplied equipment, expertise or technology and strive for reduced labour inputs.

We all realize that charcoal is energy-inefficient compared to wood or uncarbonized biomass, but it is a popular and preferred fuel. In the urban environments of most African countries it is considerably cheaper to cook with charcoal than with kerosene, gas or electricity. Charcoal demand is not going to disappear anytime soon. Charcoal- from a sustainably managed source such as woodlots or bagasse is neutral to the carbon cycle. Charcoal smokes little compared to wood; it has an easily controlled nearly flameless heat, and is safer and less toxic than wood. The Sub-Saharan market in charcoal is close to 2 billion dollars per year, according to the World Bank. This is not easily legislated or controlled. And it is certainly not sustainable in its present state.

It is obvious that the two commercial approaches to briquetting charcoal I've outlined here can go a long way toward the establishment of a sustainable wood fuel industry in Kenya. Salvaging charcoal fines increases efficiency- conceivably up to 10%. This amounts to 44,000 tons of Kenya's 440,000-ton annual consumption. If all Kenyan sawdust and bagasse were converted to charcoal briquettes, another 150,000 tons of charcoal substitute could be injected into the market. Now we are talking big impact, and via low-cost, low-tech and locally developed methods that involve local communities and large numbers of people.

PPT slide 10: *Final slide. Women carrying wood uphill on rural road. Titled 'Briquetting is one way of supporting a sustainable domestic fuel supply'*

As fuelwood resources close to cities are depleted, the price of lump wood charcoal may rise. This could result in an increased use of petrochemical fuels for domestic use, with a negative effect on the environmental carbon balance. This is yet another reason to encourage the production of inexpensive alternative charcoal fuel products.

There is a niche to be commercially exploited here, and by doing so it can only affect the environment in a positive way. We need to continue to develop simple methods of biomass conversion and to commercialize them at every opportunity. Huge mountains of sawdust are still being burned as waste. Discarded carbon powder

occurs wherever lump charcoal is sold throughout the world. Surplus bagasse is a disposal problem for many sugar factorys. The opportunities are there and complex, expensive technology is not needed- labour can be used- especially in regions that rely heavily on charcoal for domestic fuel.

Informally, I have already started to share information and experiences via the Internet. With my help, a commercial charcoal dealer in Mexico has set up a briquetting plant to salvage powders from his own operation. In Haiti, we have just started discussions and the practical benefits are mutual. We are currently looking for funds to establish a prototype carbonized sawdust briquetting plant outside of Nairobi. Once a single commercially successful plant is up and running, it can't be long before others are built.

Briquetting, in some of its forms, can certainly play a major role in both environmental conservation and the sustainable supply of charcoal fuel. It is essential though that the technology remains simple, applicable and of benefit to surrounding communities. A low cost affordable product that competes with lump wood charcoal can be produced- it's now been proven. The way forward- the only way to make a significant positive environmental impact- is to expand, replicate and to include a wide range of raw materials. We should make a concerted effort to do all of this- and as soon as possible.